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ON THE

THEORY OF INFLAMMATION.

INAUGURAL DISSERTATION.

BY

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TO

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PROFESSOR OF THE INSTITUTES OF MEDICINE IN THE
UNIVERSITY OF EDINBURGH;

THIS ESSAY IS DEDICATED,

AS A TESTIMONY OF RESPECT AND GRATITUDE.

PREFACE.

It will be observed, that many of the views advocated in the following pages, are those of the late Dr Fletcher, and in reference to these it is proper to state, that besides the ordinary opportunities of attending his lectures, I have been permitted to consult his manuscripts.

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ON THE

THEORY OF INFLAMMATION.

INTRODUCTION.

BEFORE entering on the consideration of Inflammation, it is necessary to state shortly a few of the Physiological principles upon which the views contained in the following pages are founded.

1. Life is here regarded as the action, or series of actions, produced by the operation of certain stimuli, on Irritability or Vitality, a property of organized matter.

2. Every organ possesses a specific irritability, which renders it more susceptible to the action of certain stimuli than others.

3. The principal natural stimuli to irritability are heat, blood, air, aliment, sympathy, &c., and, besides these, there are various other stimuli more

or less salutary or deleterious, which may be called accidental.

4. The result of the action of natural stimuli upon natural irritability, is natural irritation or health.

5. Any change in the stimuli—exciting cause—co-operating with any change in the irritability—predisposing cause—produces preternatural irritation or disease.

6. Irritability is exhausted by every excess of irritation.

7. Irritability is increased or accumulated by every deficiency of irritation.*

* For a fuller exposition of these principles I must refer to the work of Dr Fletcher, who has modified very considerably the original ideas of Brown.

CHAPTER I.

EXPERIMENTAL RESEARCHES.

The subject of Inflammation may be commenced with the description of the effects which have been observed, with the microscope, to arise from the application of stimuli to the transparent parts of animals.

These effects may be considered under three distinct heads or stages, corresponding to those under which Inflammation will afterwards be considered. 1st, Excitement, or the immediate effect of a stimulus on irritability; 2d, Collapse,* or the exhaustion which succeeds to every excitement; and, 3d, Reaction or recovery of irritability.

1st Stage, Excitement.—According to the observations of numerous experimenters, the first effect of the application of a stimulus to the web of the frog's foot, is, almost invariably, contraction of the smaller arteries and capillaries, attended with increased rapidity of the circulation through them. During the continuance of this state, which is evi-

* The word collapse is here, and in the succeeding pages, always used in its pathological sense, which is in Inflammation the opposite of its mechanical sense, as it is attended with dilatation.

dently one of excitement, there are no symptoms of Inflammation, the part is not red or swollen, nor are the vessels dilated or turgid with blood ; but, on the contrary, the web is paler and clearer than natural, and the vessels contracted.

This first stage has been frequently overlooked by experimenters, as, in fact, it is very little marked comparatively with the second stage; it corresponds with the period of incubation of Kaltenbrunner. Sometimes also it is apparently wanting, from the rapidity with which the action of some stimuli is followed by collapse. The contraction of the capillaries and acceleration of circulation were, however, well marked in the experiments of Hastings (*on Inflam. of the Lungs*) ; with hot water (p. 55 and 81) ; with ice (p. 55 and 82) ; acceleration without any mention of contraction in those with alcohol (p. 54) ; Tinct. op. (p. 57) ; mechanical irritation (p. 79) ; ammonia (p. 83) ; W. Philip (*on Febrile Diseases*, vol. ii.) ; contraction and acceleration with alcohol (p. 18) ; J. Thomson (*Lect. on Inflam.*), contraction, acceleration, and paleness, with ammonia (p. 84) ; acceleration with alcohol (p. 83). Kaltenbrunner (*Exp. circa stat. sang. et vas. in Inflam.*) mentions acceleration as the first effect in all his experiments, and in some, as with am-

monia, cold, vinegar, and some others, there was general or partial constriction of the vessels. In his first stage, however, he includes part of what is here considered the second stage, for he states that the vessels were dilated by a fuller wave around which their parietes were contracted or tense, and the parenchyma was swollen and red, while, at the same time, there was acceleration. The dilatation must be considered as the commencement of relaxation, and therefore belongs to the second stage. He is also obscure, and does not seem to have taken any pains, as Dr Thomson did, to distinguish between the local effects of the stimulus, and those produced on the heart by the pain and irritation.

2d Stage, Collapse.—After the stage of excitement of the vessels has lasted for a longer or shorter period, according to the character of the stimulus, it is followed, like every other excitement, by a corresponding state of exhaustion or collapse, in which the vessels, being unable to resist the distending force of the heart, become dilated and admit a greater quantity of blood. As the dilatation proceeds, the motion of the blood becomes proportionably slower and more languid, and at length apparently ceases altogether. When the

stagnation has arrived at this point, the parietes of the vessels appear relaxed ; the functions of the organ or part are interrupted ; secretion is suspended ; the arterial blood is not changed to venous ; the globules of the blood lose their form, and clots are formed. At the circumfluence of the part thus affected, the rapidity of the circulation seems increased. The part now presents every appearance of Inflammation, it is swollen, and of a bright red colour, and the vessels are dilated and turgid with blood.

From these facts it appears that the phenomena of Inflammation do not correspond with the primary or exciting effects of stimuli, but with their secondary or debilitating effect.

This secondary effect of stimuli, viz. retardation and dilatation, was observed in every experiment : it is therefore needless to particularize any individual instances,—the most complete account is given by Kaltenbrunner. With respect to the retardation, however, a slight discrepancy occurred in the experiments of Dr Thomson, and perhaps also, Kaltenbrunner. Dr Thomson found, that the dilatation caused by muriate of soda when slight, was attended with increased rapidity of the circulation. This appearance may, perhaps, it appears

to me, be explained on mechanical principles. It is not yet agreed whether the capillaries contribute to the circulation of the blood, though it is probable that they do not; but it is certain that the motion of the blood must be considerably retarded in its passage through them by friction at least, if not also by the vital processes which take place in them. Therefore, according to Dr Young (*Phil. Trans.* 1809), "The more the capillary arteries are debilitated and distended, the greater will be the mean velocity of the circulation; but whether or no the velocity will be increased in the vessels which are thus distended, must depend on the extent of the affected part; and it may frequently happen, that the velocity may be much more diminished on account of the dilatation of the space which the blood is to occupy, than increased by the diminution of the resistance." (P. 26.)

From this it appears, that a relaxation of the capillaries would, by diminishing resistance, tend to increase the velocity of the blood's motion, till the dilatation proceeded so far, that the increased quantity of blood to be moved more than compensated for the diminution of resistance. It is therefore possible, for a mechanical reason, that dilatation when it is slight and equable, may be accompanied with increased velocity of circulation; but whether the increased velocity in question is to be

attributed to this cause, our knowledge of the share which the capillaries have in the performance of the general circulation is still too imperfect to enable us to determine. In some of the experiments of Dr Thomson with muriate of soda, this dilatation and acceleration were observed, but it was only when the action of the stimulus was slight. The redness was very similar in its appearance and short duration to that excited by friction, blushing, &c. ; and if the state of vessels in these cases were proved in other respects analogous, the inference would be, that the circulation is increased in these states, and perhaps also in fever. Now, these states differ from inflammation only in degree (*J. Hunter, J. Thomson*) ; but it cannot thence be inferred, that the circulation is quickened in any case of what is usually called Inflammation, for whenever the stimulus was applied in sufficient quantity to produce a more intense degree of the symptoms to which the term inflammation might be more properly applied, retardation was invariably observed by all experimenters. And in no way does the experiment warrant Dr Thomson's conclusion, that acceleration accompanies active inflammation and retardation passive, unless it be admitted that the redness from friction, blushing, and slight stimuli, is a more active state of inflammation than phlegmon, or the action of stronger

stimuli. Besides, the distinction into active and passive, is altogether imaginary with respect to the part (*Kaltenbrunner*), and depends on the presence or absence of constitutional symptoms. We may therefore conclude, that retardation always occurs in that degree of dilatation to which the term inflammation is generally applied, although it cannot be included in a theoretical definition. *Kaltenbrunner* (*Repert. generale*, vol. iv. p. 218), restricts the term inflammation to that degree of dilatation which is accompanied with *Stases*, while a minor degree, he calls congestion.

3d Stage, Reaction.—After some time, the capillaries recover their irritability and begin to contract. The blood now begins to move more rapidly, and in proportion as the diameter of the capillaries is lessened, the circulation is accelerated, till the vessels arrive at their normal state of contraction, and the part presents its natural appearance. This return of the vessels from a state of diminished irritation or action, to the state of natural irritation, is accompanied by a secretion of serous, sanguinolent, or other matters, which differ according to the character of the inflammation.

These secretions have been particularly described by *Kaltenbrunner*, who calls them *crises*: he repre-

sents them as transuded through the parietes of the vessels in jerks (saccades). The inflammation begins to abate as soon as these crises appear, and diminishes in proportion. These crises he considers as the only termination of inflammation (*Repert. generale*, vol. iv).

The contraction of the vessels has been found to be promoted by the application of suitable stimuli, which is precisely what we should expect, for though the irritability of the vessels to one stimulus be exhausted, it may still remain with respect to another, and on the moderate application of an appropriate one they may be restored to their natural state. On this is founded the principal part of the treatment of inflammation.

In the experiments of *Hastings*, the inflammation from muriate of soda and that from muriate of ammonia were removed by alcohol; from muriate of ammonia and from hot water by ice; from hot water by turpentine; (*W. Philip*),—idiopathic, from air, and mechanical irritation, by alcohol. *Kaltenbrunner*,—various inflammations were removed by cold, alcohol, &c., &c.; but when he applied the stimuli too long, or too concentrated, the collapse for the remedy was added to that already existing, and the symptoms became worse. (*De Infl.* p 62.)

CHAPTER II.

THEORIES OF INFLAMMATION AND DOCTRINE OF
DETERMINATION OF BLOOD.

It is allowed by all that the chief symptom in inflammation is accumulation of blood in the capillaries, but the simple cause assigned here, viz. that from weakness, the capillaries are unable to prevent it, has not been so generally adopted, perhaps because it is so simple. Of all the theories on the subject, two need only be here noticed.*

1. That the symptoms of inflammation are produced, or at least accompanied, by an increased action of the larger arteries, whereby a greater

* The *Humoral Pathologists* attributed inflammation to a fluxus or determination of one of the four fluids; the *Arabians* to vitiation of the fluids; *Stahl* and *De Gorter* to a local plethora, produced by increased action of the arteries leading to the part; *J. Hunter* to active dilatation of the capillaries. It is to *Brown* perhaps that we owe the general explanation that is given above of the production of the debility, viz. that it is from exhaustion similar to the fatigue of voluntary muscles (*Flet. on Rev. post cit.*); but *Brown* unfortunately considered the general and local affection as always of the same character (*El. Med.* 42),—a fatal error, which led to the use of general stimulants and neglect of blood-letting. About the same time *Vacca* propagated the opinion of debility of the capillaries. This was advocated by *Allen* and *Lubbock*, *Burns*, and many others, and confirmed by the experiments already noticed.

quantity of blood is propelled or determined to the part.

And, 2, By active dilatation of the capillaries themselves. Of these the latter is so purely hypothetical, that it will only be considered incidentally.

As the expression Determination of Blood is very common, but also very vague, and has no very precise meaning attached to it, it will be proper to examine more fully into its nature. The heart obviously can have no power of causing irregular distribution of blood ; it is, therefore, in the arteries we must seek this power, and physiologists have in general assigned it to them in virtue of their muscularity. With respect to the existence of the muscular power of the arteries, it is impossible here to enter fully into the question, but it may be remarked that it is disproved by evidence as strong as negative evidence can be. 1st, The arterial tissue differs physically and chemically as widely as possible from the muscular. 2d, Experiments with the most powerful stimuli have failed to produce contraction in the arteries. 3d, Comparative anatomy is opposed to the supposition of their muscularity in the higher classes of animals.

The only arguments which have any weight for their muscularity are, 1st, They react with a greater

force than distended. 2d, Adapt themselves to a diminished quantity of blood; and, 3d, Undergo a constriction or corrugation by the action of cold and acids.* All these may be easily explained, if we remember that the arteries are not simply elastic tubes, like dead matter,* but contain in their coats numerous capillary vessels, which are undoubtedly muscular.†

Physiologists having proved, as they suppose, the muscularity of the arteries in general, make no difficulty as to the use of it, but at once take it for granted that it is to assist in propelling the blood. On the other hand, natural philosophers, while they do not question the muscularity of the arteries, yet distinctly assert that they do not, and cannot, in the higher classes of animals, assist in the propulsion of the blood.

One of the highest authorities on this subject, Dr Young, has demonstrated,‡ that no contraction whatsoever of the arteries could materially aid propulsion of the blood, so as to cause irregular distribution.

* The Tonicity of Parry assumes the question, for tonicity signifies a mean state of muscular contraction excited by stimuli always in operation,—and not a new property.—Fletcher's Physiology, p. 110.

† Fletcher's Physiology, i. p. 102.

‡ Philosophical Trans. 1809, to which I must refer for the arguments of Dr Young.

After considering every possible mode in which the arteries could contract—every one of them requiring a far higher degree of contractility than the most favourable experiments warrant,—and shewing that none of them could assist the propulsion of the blood, he concludes (p. 19), “but the distribution of the blood could never be materially diversified by any operation of this kind; for * * *, &c. unless the *elastic* powers of the vessel itself were diminished.” Dr Arnott also, who takes a good deal of trouble in endeavouring to prove the muscularity of the arteries, at the same time maintains that they can have no influence in the propulsion of the blood*. After referring to such authorities, it is unnecessary to enter further into the question in this place, but we may conclude that the arteries in all probability possess

* Physics, p. 530. The use Dr Arnott assigns to the muscularity of the arteries is to produce a degree of rigidity in their coats almost equal to metal, to give the necessary speed and sharpness to the pulse. But Dr Young (p. 12, *op. cit.*) has shewn that the arteries, if simply elastic, could propagate a wave at the rate of 16 feet in a second, which corresponds with what is actually observed. Besides, Dr Arnott, in the next page, refutes the opinion of Bichat and Parry, which is almost exactly the same as his own, by remarking that the stream in the capillaries is uniform. Other authorities against the propulsive action of the arteries might be cited, but as they are chiefly medical, they are of little weight in comparison with those above mentioned.

no muscular power, and that certainly even if they had, it would be of no use to them in propelling the blood and causing irregular distribution. Such being the case, it becomes necessary to explain otherwise those changes, both healthy and morbid, which have been attributed to increased action of the arteries. The arguments generally advanced in support of increased action and propulsive power of arteries are,—the increased size, pulsation, and tortuosity of arteries leading to a part in which increased secretion or nutrition is going on, as those of the uterus during gestation, of the mammæ during lactation, of the testicle during the rutting season, of the horns during periodic growth, of tumors, &c., and the increased size and pulsation of those going to a part which is inflamed. In all these cases the affection of the artery is merely secondary, the primary change being in the capillaries, which, undoubtedly, possess the power of modifying very considerably the quantity of blood transmitted through them.*

The dilatation and pulsation of the arteries

* The muscularity of the capillaries and smaller arteries cannot be doubted after the experiments already mentioned; but it may be repeated, 1st, They visibly contract when stimulated; 2d, They resist the passage of acrid, but not of bland fluids from arteries to veins; and, 3d, in almost all their functions display complete independence of any general action, for example, blushing, erection, &c.

which accompany increased secretion and nutrition, are explained by Dr Fletcher in the following manner. As secretion is, *cæteris paribus*, in proportion to the quantity of blood contained in the capillary vessels of a part, the capillaries during increased secretion retain more blood, and consequently transmit less. Hence arises an obstacle to the current of blood in the artery that supplies the part; the consequence of this obstacle is distention and pulsation in the artery; and, after some time, a species of chronic inflammation in its coats, the result of which is hypertrophy, which, when longitudinal, produces tortuosity, and, when circular, permanent increase of calibre.

In a similar way may be explained the throbbing or pulsation in inflammation, for whether the capillaries be in the same state as in increased secretion or not, it is always when there is some obstruction to the flow of blood that throbbing occurs. Thus *Hastings* (p. 48) found that the application of a ligature to the limb caused pulsation in the vessels of the web; also (p. 53) partial constriction of a vein caused pulsation in the part beyond, while the flow of blood in the rest of the web was uniform. *Kaltenbrunner* observed, that when retardation arrived at a certain degree, pulsation was seen

in the web. Marshall Hall* found that the slightest obstacle produced pulsation in the web.

In feeling the pulse, it is the obstacle to the motion of the column of blood by the pressure of the finger, that gives the sensation. Tumors pressing on an artery simulate aneurism, &c. &c.

And that throbbing is not caused by increased action of the artery is proved, *a fortiori*, by those arguments which shew that the natural pulse is not produced by contraction of the artery.† As a direct argument it is urged by Mr Hunter, that the pain of the throb is felt during the dilatation of the artery, and not during the contraction, as it ought if that contraction were muscular.‡ Nor is it produced by diminished muscular contraction of the artery, for it may be produced immediately by tying a ligature round the finger.

Throbbing is therefore not produced by increased action of the artery, but simply by an obstacle to the flow of blood through it. The obstacle to the flow of the column of blood produces distension, which becomes more or less permanent, and

* Essay on the Circulation, p. 95.

† Dr Parry (on the Pulse) has shewn this in a most satisfactory manner.

‡ On the Blood and Inflammation, p. 362. Notwithstanding this remark Mr Hunter continually speaks of increased action of the arteries in inflammation.

Mr R. A. Hall *He is the one who*
felt the pulse in the web of the foot
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the calibre of the vessel is often sensibly enlarged.* The latter effect may probably be aided by some change in the coats of the vessel, as it has been found that a portion of the artery going to an inflamed part reacts with less force than a similar portion from a sound limb.† It may be asked, if there is obstruction in Inflammation, how does it happen, that in some cases a greater quantity of blood is returned by the veins than in the natural state, as asserted by Mr Lawrence? It has not yet, however, been ascertained at what period of inflammation, or in what kind, this takes place, if, indeed, it occurs at all; for the experiment on which this conclusion is founded is of a very uncertain nature, and would require farther repetition.

Nor is it inconsistent with what has been said, for it must be recollected that the artery is frequently dilated, and thus a larger quantity of blood

“ * The cause of common dilatation of the larger arteries, and still more that which is preternatural, is the mechanical distending power of the blood they contain” (p. 78, Parry). In Parry’s experiments xxiii. and xxiv. the carotid was dilated immediately on tying the opposite one: see also in exp. xvii.

† See the Experiments of Dr Alison, Edinburgh Medical and Surgical Journal, vol. xlv., also Dr Pring states that the arteries of an inflamed part, if cut, will bleed longer than others of the same size. (*Pathology*, p. 169.)

may pass through, although it be not in proportion to the dilatation of the artery. But in general we may consider that the quantity of blood transmitted through an inflamed part is about the same as in health: more is contained in the vessels, but it is moved more slowly.

From these, then, we may conclude,

That the seat of the primary change in inflammation is in the capillaries alone; and that it consists in *the collapse, or diminished vital action, which follows excessive excitement of these vessels*.*

It is to be remembered that diminished action

* When we consider that the capillaries are resisting a distending force of 4 lb. on the square inch, and when we know that every increased excitement is followed by a proportional degree of collapse, we naturally conclude that the dilatation of the vessels which follows the action of a stimulus arises from their inability, from exhaustion, to resist the distending force. With such views, it must be a matter of astonishment that the opinion, for long the most prevalent, and supported by the highest authority, is directly the contrary, viz. that the dilatation is produced by increased action, and the influx of blood the effect of it (*J. Hunter*). The inconsistencies to which this hypothesis leads are very numerous, but it may be merely remarked at present, that we have no proof that excitement will produce direct dilatation in any tissue, and it is so obviously contrary to all analogy with respect to the muscular, that Mr Hunter is obliged to suppose relaxation of the muscular fibres of the capillaries with active dilatation of their elastic coat. But when there is a relaxation, with such an internal pressure, what need is there of any other power to produce dilatation? Also relaxation can never arise directly from excitement, but only indirectly.

does not here mean merely diminished muscular contraction, but a diminution of all vital action whatsoever. In fact, precisely the opposite of the definition given by Mr Hunter, who considered inflammation as “*increase of life.*”

It has been objected, that the theory of simply increased or diminished action is quite inadequate to explain the numerous phenomena which are usually comprehended under the term Inflammation. All this, however, will be considered presently, when inflammation will be shewn to consist of three distinct stages, to one of which only the term is usually applied ; but in the mean time it may be observed that the essential nature of the state of inflammation must be a simple increase or diminution of the natural action of the capillaries, because it may exist without any other alteration of the action of these vessels whatsoever. And in considering the nature of inflammation generally, the celebrated axiom of Brown, viz. “Health and disease are the same state, that is, Excitement, varying only in degree,” will be found applicable to its fullest extent.

It is true that alterations of action (besides difference in *degree*) may frequently coexist with inflammation ; and in the consideration of special inflammatory diseases, it is necessary to take these

into account ; but in the consideration of inflammation as a particular Pathological condition, we have nothing to do with them, and they must be referred to head of “ Predisposing and Exciting Causes of Disease.”

It is the business of the Physiologist and general Pathologist to explain (if he can) why the operation of one stimulus should produce the natural and healthy action of a part ; while that of another should give rise to an action altogether different and morbid ; and when he does so (which will probably be never), he may, with equal ease, explain why inflammation should at one time terminate in a simple increased secretion of natural tissues and fluids, and at another, in a secretion of matters altogether preternatural. Besides, alterations are practically of little importance, as almost all our remedial means are simply those of increasing or diminishing action.

2d, Inflammation is frequently accompanied by increased action of the heart, but *never* of the arteries. | 2

3d, Irregular distributions of blood are produced *primarily* by the capillaries retaining part of the blood which passes through them, and not by receiving a greater quantity from the arteries, although this last may happen afterwards, the arte-

ries being *secondarily* affected. Therefore, for the expression Determination of Blood, ought to be substituted, Irritation.

I may here quote from Dr Fletcher a remark, which shews strongly how completely unnecessary the supposition of a determination of blood is, to explain the occurrence of inflammation or increased secretion. After mentioning the large quantity of blood received daily by each organ, he says, “Is it necessary, for instance, to imagine, that there must be any increased determination of blood to the brain, to explain the occurrence of sanguineous apoplexy upon the presumption that the 1800 lbs. per diem cannot furnish, without some additional supply, the half dozen drops which are abundantly sufficient for the production of this disease ; or that the operation of a diuretic medicine must be by determining more blood to the kidneys, upon the presumption that the 450 lb. just mentioned cannot of themselves spare half a dozen oz. more to be turned into urine ?”

CHAPTER III.

NATURE OF INFLAMMATION AND FEVER.

UNDER the general term Inflammation, are comprehended three distinct stages, viz. 1st, Excitement ; 2d, Collapse ; and 3d, Reaction, or increased Secretion. But it is to the second alone of these that the term is usually applied, while the first is called latent, and the third comprehends the different modes in which inflammation is said to terminate, such as resolution, adhesion, suppuration, &c. Dr Fletcher, however, very properly considers all these last as modifications of the same process, viz., Reaction, which, being attended with a great variety of increased secretions, no one secretion has any title to be called a distinct termination more than another.

This chapter will be devoted exclusively to Dr Fletcher's arrangement of the phenomena of inflammation, which is quite peculiar, inasmuch as it takes into account the mysterious and hitherto inexplicable latent stage, and points out the identity of the nature of fever with that of inflammation.

Along, therefore, with Inflammation we shall con-

sider Fever,* which in its commencement, course, and termination, is in every respect analogous to inflammation, and differs from it only in seat and degree. The seat of inflammation may be in any part, and the degree of the affection of the vessels is commonly considerable; whereas the seat of fever is always the whole surface of the body, and its degree slight, with respect to any given number of capillaries as compared with a similar number in inflammation; but the number of those affected more than compensates for the slightness of the affection of each, and the constitutional symptoms are, therefore, proportionally greater.

1st Stage, Excitement.—The first effect of an exciting cause of Inflammation, which is always either primarily or secondarily stimulant, is increased excitement or irritation, attended with constriction of the capillaries of the part, and blanching, from the expulsion of the blood contained in them. Thus, on the application of a blister to the skin, the redness, swelling, &c. which are characteristic of Inflammation are not immediately produced,

* “Fever and Inflammation, therefore,” says W. Philip, “seem to differ, only in the one being a general, and the other a local affection; to which all the differences in the phenomena of these diseases may, I believe, be easily traced.” (*On Febrile Diseases*, vol. i. p. viii.) ; also Kaltenbrunner. (*Repert. Generale*, p. 231, vol. iv.)

but a period intervenes in which there is paleness, but no other very obvious sign of action—this is the period of excitement. The preternatural constriction of a limited number of capillaries, which occurs in the first stage of Inflammation, is in general attended with so few remarkable symptoms, that it has acquired no particular name, but is spoken of as the period of incubation or *latent stage*. In fever, however, from the great number of capillaries affected, the symptoms are much more marked, being in fact those of the *cold stage*. The constriction of the capillaries of the surface produces the coldness and paleness of the skin, and shrinking of the external parts of the body; while the interruption of the circulation in so large a number of vessels, gives rise to accumulation of the blood in the central parts of the body, and great oppression and disturbance of the organs of circulation and respiration. The accumulated blood acting “more as a load than a stimulus,”* oppresses the heart, and the pulse is quick, small, and even irregular. The breathing is also hurried and laborious, with the feeling of tension in the præcordia. In consequence of the intimate sympathy† which subsists between the capillaries of the

* *Fletcher's Physiology*, part ii. a p. 126.

† With respect to the nature of sympathy, and those parts which are particularly connected through its means, I must refer

skin and those of the grey matter of the brain and spinal cord,* the latter are also constricted, and by the consequent exclusion of blood the functions of these organs are much impaired ; hence the confusion of thought and dulness of the senses. By sympathy the capillaries of the stomach are also affected in a similar manner, hence interrupted digestion, want of appetite and nausea.

The capillaries of the secreting organs being likewise constricted, there is general diminution of the secretions, the mouth and throat are dry, the bowels costive, and the urine pale and scanty. From the predominance of the symptoms of debility in the cold stage, and those of excitement in the hot, it is difficult to divest our minds of the idea that the primary affection in the former is diminished action, and in the latter increased ; accordingly, in the theories of fever such has generally been considered to be the case.

It is quite impossible in a treatise like this, to consider the numerous theories of Fever, which

to works on Physiology, in which the subject is now so fully discussed as to supersede the necessity of any elementary notice in a Pathological treatise.

* It is now pretty generally admitted that the grey matter is the origin of nervous influence ; but I must again refer to works on Physiology for proofs of this. See in particular Fletcher's Physiology, parts ii. and iii.

have been at different times advanced, but we may notice two of the most celebrated, in order to contrast them with that of Dr Fletcher which is given here. *Cullen* conceived that the primary affection was debility of the brain produced by a sedative exciting cause—next debility of the extreme vessels with spasm, but as it was difficult to conceive how debility could produce spasm, he was obliged to have recourse to the vis medicatrix,—the spasm produced increased action of the heart which lasted till the spasm, and with it the debility, was overcome. On this theory it may be remarked, that the existence of a positive sedative cause, and of the vis medicatrix, are hypothetical, and Cullen forgot to make the spasm relax, which it certainly does, in the hot stage. *Brown*, rejecting the vis medicatrix, attributed the cold stage to debility from a sedative cause, and the hot to accumulated irritability; but at the same time he maintained, that all positive agents were stimuli, and, therefore, poisons and contagions operated merely negatively by less stimulating—a supposition which is quite inadequate to explain their action. The view of *Dr Fletcher* is by far the most consistent, as it completely reconciles the operation of the exciting cause with what is observed of the action of stimuli in the production of Inflammation. The stages of con-

tinued fever corresponding to the cold, hot, and sweating of intermittents, have been called the stages of, 1st, Oppression ; 2d, Reaction ; and, 3d, Collapse, which names are very proper for the state of the general system, but not of the part affected, for during the first the capillaries are in a state of excitement, and in the second relaxation or collapse, and in the third incipient reaction.

2d Stage, Collapse.—When the state of increased irritation of the capillaries has lasted for some time, it is followed by corresponding diminished irritation and relaxation, in which state they are unable to resist the distending force of the heart (which is at this time generally increased), and are consequently dilated ; hence arise the characteristic symptoms of inflammation, redness, swelling, heat, and pain.

The *swelling* arises at this period solely from the increased size of the capillary vessels, but afterwards there may be effusion. (*J. Thomson*, p. 48.)

The *heat* is attributable to the increased quantity of blood, for it never rises above that of the heart. (*J. Hunter*.)

The *redness* is caused by the increased quantity of blood, and the brightness of the colour to its

being arterial,* imperfectly changed to venous, on account of the diminished action of the vessels. The redness in transparent parts is not from the formation of new vessels, but merely from the red particles entering vessels, which were too small to admit them.† (*J. Thomson.*)

The *pain* is produced by the pressure and irritation of sensifc nerves by the distended vessels.

In fever the capillaries of the surface being now relaxed, the blood enters and distends them beyond their natural diameter, so that the heat, redness, and fulness of the surface, are not only restored, but raised above the natural standard. While the blood being permitted to flow freely through the capillaries, the heart is relieved from the load which oppressed it, and the pulse becomes frequent, full, and strong. The capillaries of the grey matter of the brain and spinal cord being also relaxed, more blood enters, and the energy of these organs is increased; hence delirium, sleeplessness, restlessness, and increased acuteness of the senses. In this second stage of Inflammation and Fever, there is not only diminution of the contractile power of

* J. Burns (on Inflammation, vol. i. p. 355.)

† Marshall Hall says that all vessels receive red particles, and, therefore, it is merely from their greater quantity and slower motion.

the capillaries but of their general functional powers, hence the secretions are interrupted and depraved. In fever the skin is dry, the urine is scanty and high coloured; and the dryness of the mouth and fauces, thirst, and character of the stools, indicate the state of the mucous membrane of the alimentary coat. In Inflammation, also, the same takes place, the serous and mucous membranes are dry,* &c., and it has also been observed in the experiments of Kaltenbrunner.† It is this stage that in fever is called that of reaction. It is unnecessary here to notice the various divisions of Inflammation that have been made, further than to observe that they are all very imperfect, as every tissue is susceptible of a different kind; and not only that, but each tissue is probably liable to many different kinds, for example the skin.

The division of inflammation into active and passive is, as before observed, imaginary with respect to the part affected, but is of great practical importance, as it refers to the state of constitution in general.

* “ It is the constant effect of violent Inflammation to stop both exhalation and absorption.”—(*Encycloped. of Pract. Med. art. Inflam.* p. 764.)

† It is owing to this that Kaltenbrunner was generally disappointed in his endeavours to obtain a view of the process of secretion.—(*Repertoire Generale*, vol. iv.)

3d Stage—Reaction or Increased Secretion.—After the second stage has lasted some time, the capillaries frequently recover their irritability, and return to their natural state. This may happen in two ways, 1st, Speedily and completely, with no very sensible evacuation from the part, but generally a discharge from a distant organ,—Resolution; and, 2d, Gradually with increased secretion from the part.

I. *Resolution.*—It frequently happens that in inflammation and fever the capillaries wholly recover their irritability, and return speedily and completely to their natural state of irritation. Now, it must be remembered, that in the state of health, or natural irritation, each organ or part affords a certain degree of stimulus to the other parts connected with it by sympathy, and, consequently, when inflamed, or in a state of diminished irritation, it must communicate a less than ordinary stimulus to those parts. When, therefore, it returns to health, or its irritation is *raised up* to the healthy standard, the additional irritation acts as a stimulus on the capillaries of a distant organ, and excites constriction and collapse, rapidly followed by increased secretion, constitut-

ing what has been called a *Critical Discharge*.* Critical discharges are thus to be regarded rather as the consequence or indication of the cure of inflammation than as the cause of it. They were supposed by the humoral pathologists to consist of the peccant or morbid matter, whose presence caused the disease, and it was to imitate the process of nature in expelling this morbid matter, that recourse was had to evacuants, which were thence called Revulsives. A very different explanation, however, will be given of these remedies in its proper place.

Sometimes, however, the collapse produced by the secondary or sympathetic irritation is not so quickly followed by reaction as to cause an increased secretion or critical discharge; but the capillaries remaining dilated, constitute a secondary inflammation called *Metastasis*. Examples of metastasis are seen in rheumatism, gout, cynanche, parotidea, &c. The sympathetic inflammation or metastasis, like critical discharges, were, or are

* This explanation of Critical Discharges and Metastasis is due, I believe, solely to Dr Fletcher. It is announced in his *Physiology*, Part ii. p. 8.

Every increased secretion takes place by a process which differs from inflammation only in *degree*. A purgative, for example, acting as a stimulus to the capillaries of the mucous membrane of the intestines, causes constriction, collapse, and increased secretion (*Fletcher*).

still, considered as the cause and not the consequence of the cure of the primary one; and it is in imitation of them that counter-irritant remedies are employed. The common explanation of counter-irritants is, as we shall see, not less gratuitous and unsatisfactory than that of revulsives. It has been observed, that the irritability of the capillaries has a tendency to revive and again to fail at certain stated periods, as in intermittent fevers and other intermittent affections. This cannot be explained, but must be referred to the laws of periodicity, which are entirely unknown.

II. *Increased Secretion*.—Frequently the vessels do not recover their irritability so quickly or completely as in resolution, but more gradually, and they remain partially dilated. In this case, as secretion from the capillary arteries (*Flet.* ii. 26) is, *cæteris paribus*, great in proportion to the quantity of blood they contain, these vessels, as they slowly recover their irritability, act upon the greater quantity of blood contained in them, and give rise to increased deposition of solid or fluid matters. In this stage of intermittent *fever*, the capillaries of the surface returning to their natural state of irritation and contraction,—the heat, redness, and fullness disappear, and a copious secretion of sweat is

poured out,—hence it is called the sweating stage. By sympathy with those of the skin, the capillaries of the grey matter of the brain and spinal cord become also constricted, and the symptoms of the violent action of those organs gradually subside, the patient often falling asleep. In this stage of continued fever, the heart is so much exhausted that it has been named the stage of collapse, although, as already remarked (p. 28), the capillaries are in a state of incipient reaction.

In the third stage, inflammation may give rise to increased secretions, so numerous and important that nothing more can be done in a treatise like the present, than merely enumerate those which Dr Fletcher considers as such, without even attempting to prove that they all have their origin in that state.

In this stage, inflammation, in the way above mentioned, may give rise to various increased depositions of healthy tissue constituting hypertrophies, strictures, adhesions, granulations, ossifications, &c., also to other matters altogether preternatural, such as tubercles, melanosis, encephaloid matter, scirrhus, hydatids, worms, calculi, &c. many of which are susceptible of subsequent inflammation, and thus becoming further proximate causes of disease. Why Inflammation should at one

time give rise to natural, and at another preternatural depositions, cannot, in the present state of our knowledge, be explained, but must be referred to a peculiar diathesis. These solid organized matters appear to be deposited in the form of coagulable lymph, which has been described as the effused fibrin of the blood, but is now almost universally considered to be a secretion. There are still, however, two opinions with respect to the mode in which lymph becomes organized, the one that it is organized from without, by the vessels and nerves shooting into it from the surrounding parts ; and the other that it contains within itself the germs of its future nerves and vessels, which being developed in its substance, gradually extend to the neighbouring parts. This subject is one of too great extent to be discussed here.

Besides these solid matters, organized or inorganized, Inflammation still more frequently gives rise to increased fluid secretions—natural, as mucus, bile, saliva, stool, blood, halitus, &c. or preternatural, as air and pus. Among these, it may be observed, are included the fluids of hæmorrhages and dropsies, which it would not be difficult to shew are never extravasated by rupture or mechanically strained through the vessels from weakness, but always poured out by the process of secretion, and

as a termination of Inflammation. Into this subject it is impossible to enter further here.

Gangrene.—The terminations of Inflammation in resolution and increased secretion may be regarded as vital processes brought about by the reaction or recovery of irritability of the capillaries ; but it sometimes happens that the irritability of the vessels is quite irrecoverable. In this case the Inflammation passes gradually into Gangrene, and at last total destruction of the vitality of the part, or sphacelus ensues. This is called the termination of Inflammation in mortification, but it must not be confounded with the other terminations in which there is a distinct change of state, while this is merely an aggravation of a state of diminished irritation, viz. Inflammation, to a point at which recovery, or the further continuance of life is, impossible.*

* “ In some cases in which Gangrene immediately succeeds to Inflammation, these two morbid states may, in some measure, be regarded as stages or periods of the same disease.” (*J. Thomson*, p. 506.)

The following is a Diagram of the STAGES of INFLAMMATION and FEVER, given by Dr FLETCHER.

STAGES.

	1st. EXCITEMENT.	2d. COLLAPSE.	3d. REACTION.
[INFLAMMATION, (any part.)	{ Intermittent continued. }	Swelling, redness, heat, and pain.	Increased secretion.
FEVER, (surface of body.)	{ Intermittent continued. }	Hot { Excitement at central parts.	Sweating. { Collapse at Sweating { central parts.

Varieties of 3d Stage—Terminations.

RESOLUTION,	. . . . .	{ Critical Discharges, Metastasis.	{ Urine, Stools, Sweat and Blood.
INCREASED SECRETIONS	. . . . .	{ Natural Tissues in excess,	{ Cellular, Mucous, Serous, Cartilagi- nous, Osseous, &c.
	. . . . .	{ Preternatural Tissues,	{ Tubercle, Melanosis, Encephaloid, Scirrhous, Hydatids, Worms.
	. . . . .	{ Natural Fluids in excess,	{ Fat, Stools, Mucilage, Bile, Pan- creatic Fluid, Urine, Saliva, Se- baceous Matter, Halitus, Blood.
	. . . . .	{ Preternatural Fluids,	{ Air and Pus.

GANGRENE.

CHAPTER IV.

ACTION OF EXCITING CAUSES.

The exciting causes of Inflammation, as of disease in general, may be all considered as variations of the stimuli, which, when natural and acting on natural irritability, give rise to natural irritation or health. The exciting causes of Inflammation are then preternatural stimuli, and like the natural stimuli may be either external or internal. Among the external may be mentioned, heat, mechanical injury, chemical agents, and contagious and infectious miasms ; those within the body are irritations operating as stimuli by sympathy. All exciting causes act by producing, primarily or secondarily, increased irritation, which is followed, sooner or later, by corresponding collapse. All positive exciting causes effect this directly by increasing the stimulus ; while negative agents do the same indirectly by increasing irritability. Heat, mechanical, chemical, and, in short, all positive agents act simply as stimulants, and produce Inflammation, as already described. The collapse also frequently

comes on *during* the action of the exciting cause, as when the skin is reddened by exposure to heat, or by the contact of irritating substances, and the further application of the exciting cause seems merely to exhaust further the irritability of the vessels, and thus increase the collapse, without producing previous constriction. Perhaps this circumstance has contributed much to maintain the erroneous view of the nature of Inflammation that is generally taken. In experiments with irritating substances, after a short time redness and swelling appear, and as these are the first marked signs of action under the application of a stimulus, they are naturally considered as indications of excitement. When the application is longer continued, the redness increases, and the excitement apparently rises higher; but when the application is still longer continued, the part is found to be, not in the highest degree of excitement, but in the state of Gangrene which is the absolute cessation of all vital action. At what point, then, the vessels of the part have passed from the highest state of excitement to one of total cessation of action, has not been indicated; and no wonder, because it has already passed when the redness begins to appear.

The action of cold and other negative agents cannot, however, be explained in the same manner.

As heat is one of the most essential and constant stimuli to irritability, cold, which is merely the diminution of it, must be a direct sedative, and tend primarily to diminish irritation. But as every diminished irritation gives rise to increase or accumulation* of irritability, the usual stimuli (or still more powerfully additional stimuli) after or during the action of cold cause increased irritation followed by collapse. Suppose a part of the body be suddenly cooled down to zero,—as by a portion of freezing mixture falling on the hand,—instant accumulation of irritability takes place, and the heat communicated from the surrounding parts, viz. 98 degrees, acts in the same way as a similar quantity of caloric applied to the part in its ordinary state would have done, *i. e.* produces increased irritation followed by collapse. Thus a freezing mixture at 0° produces ultimately the same effect as water heated to 196°. It is scarcely necessary to repeat that cold can never, any more than blood-letting, want of food, or any other negative agent, be primarily stimulant, but it is so indirectly, and a most powerful one, both as an exciting cause of disease and a therapeutic agent. Cold, by its primary

* I use this expression merely for convenience, for, of course, as irritability is only a property of organized matter, it cannot be said to be accumulated *per se*. For explanation, see *Flet.* ii. p. 125.

action in directly diminishing irritation, appears in some cases to give rise to a state analogous to inflammation. This is seen in the redness of the nose, cheeks, legs, and other parts exposed to cold: and it was particularly remarked in the experiments of Dr Spooner, who found that the parts which were in contact with the snow became red and swollen. Rheumatism, toothache, &c. appear also sometimes to be produced in this way when they occur during exposure to cold as from sitting in a draught. But it is by its secondary operation that cold most frequently acts and becomes the most common of all exciting causes of disease, producing, by its local action or by sympathy, fevers, synanche, bronchitis, pneumonia, catarrh, enteritis, chilblain, frostbite, &c. &c., some of which are partly owing to the suppression of the cutaneous transpiration. Another frequent exciting cause of inflammation is *Sympathy*. By sympathy an increased irritation in one part may become a stimulus to the capillaries of a distant part, and there excite increased irritation followed by collapse. In this way are produced Inflammations from the healing of old ulcers, or the sudden suppression of secretions, healthy or morbid, and also symptomatic fever from local Inflammation.

Increased secretion always implies diminished

irritation, being in fact the third stage of Inflammation, and therefore the suppression of it implies increased irritation, which acts on a distant part, and produces Inflammation, as already explained under the head of metastasis and critical discharges. The bad effects, such as headaches, pulmonary complaints, &c. from the healing of old ulcers, catarrh, &c. from suppression of the sweat and numerous diseases from sudden suppression of the menstrual discharge, cannot be supposed to arise from the non-evacuation of the fluid, for that would merely increase the general mass of the blood, and act as a predisposing cause only and equally on all parts of the body, but must be attributed to the increased irritation which attends the suppression, except when the blood becomes the vehicle of exciting causes by the absorption of excretions or vitiated secretions, (urea, bile, &c.) With regard to the manner in which local Inflammation acts as a stimulus in the production of increase of heart's action, and symptomatic fever in general, it is unnecessary to enter here into the consideration of the conveyance of sympathy. It may be, however, remarked, that it cannot be by sympathy with the inflamed vessels that these effects are produced, as these are in a state of diminished irritation: but in all probability it arises from the contiguous tissues

being affected in the same way as the sensific nerves in the production of pain.

All contagious and infectious miasms and viruses act as stimuli in the production of fever and inflammation, and the duration of their exciting effects, like other stimuli, is what has been called the *Latent Stage*. As all the other effects are merely the consequences of the increased excitement during the first or latent stage, it is plain there must be some connexion between the intensity of the first stage and that of the subsequent ones. Accordingly, it is stated by Dr Fletcher, that "*Cæteris paribus* the disease is dangerous, according to the length of the latent stage."

In applying this principle, however, *cæteris paribus* must be constantly kept in mind, for the *cætera* are not always, indeed very seldom, *paria*. Thus, it does not hold good at all in comparing the action of *different* miasms and exciting causes: for example, in plague, bites of venomous animals, and some other powerful stimuli, the collapse comes on almost immediately, and yet these diseases are always highly dangerous, and often fatal. In intermittents of different types the hot stage does not correspond to the length of the cold. Also with respect to the *same* miasm in some cases of great susceptibility the collapse may come on very soon,

and yet the disease prove fatal, while in other individuals there may be a considerable latent stage, and yet the disease prove mild.* But in all these cases it is clear that the collapse or exhaustion of irritability would have been greater if the action of the exciting cause had been longer continued, and if the disease consists in the collapse it would have been more dangerous ; therefore the principle above stated may be quite correct, if the *cæteris paribus* be always kept in mind. By means of this principle may be explained the action of those remedies which occasionally cut short fever : they all in fact act by shortening the latent stage. Emetics produce, by sympathy with the stomach, constriction of the capillaries of the skin, which is speedily followed by relaxation, and thus the full formation of the first stage is prevented, and the subsequent stages rendered more mild. The cold affusion, and other means, act in a similar manner. On the same principle Dr Fletcher explains the greater mildness of inoculated variola.

The virus being applied in a concentrated state produces such a powerful exciting effect that the

* But it is remarked by Dr Traill (*Clinical Lecture*), that, in general, those individuals who, after being exposed to the contagion of continued fever, appear to bear up against the disease for a considerable time after their infection, *i. e.* those who have a long latent stage, have it in a bad form ; while, in those who are speedily laid up, it is comparatively mild.

collapse comes on soon—thus the latent stage is shortened and the disease rendered milder.

With respect to the question on what tissue the exciting causes of inflammation primarily act, we have nothing here to do ; for as all stimuli, *i. e.* all exciting causes both of health and disease—act primarily on irritability, this question merges into the more general physiological one, whether the capillaries possess irritability as an inherent property, or whether it is only in virtue of the ganglionic nervous matter with which they are furnished that they possess that property.

Changes in the Blood.

The changes which the blood undergoes in inflammation are few and comparatively unimportant, as they are in every case secondary. Of these the most remarkable is the buffy coat which is formed by the more forcible cohesion of the particles of the fibrin. The probable cause of the buffy coat has already been adverted to, but it may here be given more fully as explained by Dr Fletcher.

The blood, in the living body, may be considered as a peculiar fluid, whose ultimate elements are held together by vital affinities which are very slight, so that it is continually tending to resolve itself into the chemical proximate principles of

which it is found to consist, after being drawn from the body, viz. fibrin, albumen, ozmazome, &c. and it is only prevented from so doing in the living body, by the constant decomposition and recombination which it undergoes in the parenchyma. This decomposition takes place in the capillary arteries, while the recombination is performed by the capillary veins. Now, in all inflammatory diseases which consist in diminished action of the capillary arteries, the decomposition is only imperfectly performed, and a portion of the blood passes unchanged into the veins: hence the venous blood acquires more of the albuminous and more coagulable nature of arterial blood.*

* It has been already mentioned, that the globules of the blood have been seen, by Kaltenbrunner, to pass from the arteries to the veins unchanged, retaining their arterial appearance and colour.

It was observed by Dr Alison, that in an incipient Inflammation of the wrist, the veins returning from the part were the first to exhibit the buffy coat.

CHAPTER V.

TREATMENT OF INFLAMMATION.

We now come to the treatment of Inflammation; and here the theory of diminished action shews itself, not a mere matter of curiosity, but of great practical value, as it enables us to explain satisfactorily every method of treatment which has been found useful.

The healthy state of the circulation may be considered to consist in a proper balance between the distending force of the heart, and the resistance of the capillaries: while, in Inflammation, there is diminished resistance of the capillaries, and consequent distension and accumulation of blood in them. The indication for the cure is, therefore, either to diminish the distending force, or to stimulate the capillaries to contract with increased force, so as to expel the blood which is oppressing them as a load. In some cases, one of these means may be sufficient, but in general it is most advantageous to employ both combined.

On these principles, the remedial means may be arranged, as has been done by Dr W. Philip, under two heads.

1st, Those which diminish the momentum of the blood, and thus relieve the capillaries of the load which oppresses them ; and

2d, Those which stimulate the capillaries of the part affected.

1st, *Relieve the Capillaries.*

The most obvious means of relieving the distended vessels, is by abstracting a portion of the blood from the part by leeches, scarifications, cupping, &c., or by diminishing the general tension of the vascular system by general bloodletting, or the employment of such remedies as depress the contractile power of the heart. General bloodletting is plainly the most powerful of all the remedies of this class : for it not only diminishes the volume of the distending fluid, but also, in a much greater degree, diminishes the general vascular tension, by its sedative effect in lessening the force of the heart's contractions.

Along with bloodletting may be classed part of the action of evacuants, such as purgatives, although, perhaps, the greatest part of the benefit derived from them may be explained on another principle.

The action of the warm bath may also be considered as partly similar to bloodletting, viz. by suddenly filling the capillaries of the surface with blood. Under the same head may be classed rest, abstinence, and the abstraction of all those stimuli which tend to excite the action of the heart: also the administration of those medicines which depress the power of the heart, such as nauseants, narcotics, and sedatives indirectly, and large doses of tartar emetic directly. All these remedies are thus merely negative in their operation on the affected part, for by diminishing the distending force, they only *allow* the capillaries to contract. But at the same time they are plainly the most direct and effectual means of relieving the distention of the vessels; and in many Inflammations, particularly those attended with constitutional excitement, until they are employed all other remedies are useless or even injurious.

In Fever, these means are to be employed with reference to the constitutional symptoms; but it often happens, as in Typhus and the stage of collapse (of the system) of continued Fever, that, instead of these, general stimuli are imperatively called for.

2d, Stimulate Capillaries.

It has been already said, that the susceptibility of the vessels to one stimulus may be exhausted, while it may remain little, if at all, impaired with respect to another: and, as in Inflammation, the vessels are in a state of collapse from the excessive action of one stimulus, our object in the treatment—after relieving them of a part of their load—is to apply, in moderate quantity, another stimulus which may restore them to their natural irritation and contraction.* This may be effected in three ways:—

1st, Directly, by local applications;

2d, Indirectly, by acting on a part connected by sympathy with the inflamed part; and,

3d, By acting on the part through the general system, by the specific effects of medicines.

I. *Local Applications.*—When the Inflammation is superficial, or within the reach of local applications, the remedies commonly employed are, heat, and various lotions, collyria, injections, &c., all of which are undoubtedly stimulant, and directly increase the action of the capillary arteries, and thus

* J. Hunter says that the indication for the cure of Inflammation is to make the vessels contract. (*On Infl.*, pp. 422 and 440.)

restore them to their natural state. Heat, in all its forms, such as cataplasms, fomentations, &c. is certainly a stimulus. The action of heat, alcohol, turpentine, and other stimulating substances, in burns, has baffled all attempts at explanation, and will continue to do so, as long as the heat, pain, redness, and swelling, are ascribed to increased action of the vessels; but the explanation becomes simple and obvious, when we admit that these symptoms depend on exhaustion of irritability, so that the ordinary stimuli are insufficient to maintain the requisite irritation, and therefore additional stimuli must be had recourse to.*

Cold is also a powerful and useful agent in the treatment of Inflammation. It may be employed as a stimulant by its secondary action, but perhaps in most cases it acts negatively, by relieving the debilitated vessels from an excessive stimulus, viz. heat, which is continually further exhausting their remaining irritability, and thus renders them more susceptible to the other natural stimuli, or to new ones, such as other remedial means.† Along with this action of cold, may be mentioned the necessity of removing the exciting cause, and all other sti-

* J. Hunter says that heat cures burns by making the vessels contract. (p. 276.)

† "Cold stops the waste of excitability." (*J. Brown, El. Med.*, vol. i. p. 105.)

muli which are not adapted to the state of the vessels, as they merely tend to exhaust further their irritability, without producing contraction. The various lotions, collyria, gargles, injections, and other local applications to inflamed parts, are certainly stimulants; for, says Dr Thomson (p. 184), “The continued application of most of these substances, so far from subduing, would aggravate Inflammation; they would even excite that state where it did not previously exist.”

Likewise all our remedies for chronic cutaneous eruptions (or inflammations) are stimulants, as pitch, citrine ointment, washes of corrosive sublimate, &c., sulphur and other medicated baths, &c.

Also the inhalation of iodine and other medicated vapours in chronic bronchitis and laryngitis.

On the same principle may be explained the action of electricity, galvanism, the moxa and acupuncture in deep seated inflammations, as these means are unquestionably powerful stimulants. Nothing can better illustrate the erroneous nature of the doctrine of increased action in inflammation, than the extreme vagueness and inadequacy of all the explanation of the action of the remedies of this class, viz. local applications. On this subject J. Hunter is singularly inconsistent. Having pre-

sumed that the dilatation and muscular relaxation in inflammation arise from increased action, he was obliged to suppose, contrary to all analogy, that the contraction of the vessels is to be effected by *weakening* them ; cold, he says, at p. 441, acts thus ; while, at p. 443, he says that heat excites action, and thus produces contraction. Bark and many stimulating applications produce contraction ; but, at p. 443, he says, acids, alcohol, and many neutral salts, do so by their sedative power. This may be compared with the passage above quoted from Dr Thomson.

It may be remarked, that perhaps much of the misconception of the real nature of action of local applications, arises from the want of precise ideas respecting the difference between irritability and sensibility, which are totally distinct properties. Some applications having narcotic powers, relieve pain, by acting on the sensific nerves, and are said to act by allaying pain and *irritation*, the latter word being used in an ill-defined and always morbid sense. From analogy with these—by far the smaller class of remedies—other applications are said to act by allaying irritation, whereas the greater number of them possess no power whatever of alleviating pain, except by curing inflammation,

may, so far from that, are highly irritating in every sense of the word, *e. g.* nitrate of silver.

II. *Stimulating by Sympathy*.—If the operation of direct remedies has been little understood, still less has the action of those which act indirectly, *i. e.* those usually as a class termed Revulsives consisting of purgatives, diuretics, diaphoretics, sialagogues, errhines, epispastics, &c. The action of these remedies has, at different times, been explained, or attempted to be explained, on the principles of *Revulsion*, *Derivation*, and *Counter-irritation*, which we may now proceed to consider.

The origin of the term Revulsion has been already mentioned under the head of Critical Discharges, and as the theory which gave rise to the term has been entirely abandoned since the decline of the Humoral Pathology, no farther notice need be taken of it here.

The next hypothesis which has been framed for the explanation of these remedies is that of Derivation, by which it is meant, that, by determining the blood in greater quantity to another organ or part, it may be withdrawn or derived in the same proportion from the diseased part.

This explanation, in the *first* place, assumes that more blood is actually sent to an organ en-

engaged in increased secretion ; to the intestines for example, during the operation of a cathartic. But it has been already shewn, that any such increased determination is entirely devoid of proof ; and no reason has been given for thinking that it is highly improbable and unnecessary (see p. 22) ; while in chronic increased secretion or nutrition, as in new growths, the case is different as already explained (see p. 16). If no increased quantity, therefore, of blood be sent to the secreting organ, that which is evacuated must be subtracted from the amount returned by the veins, and thus the evacuation will, like general bloodletting, affect the whole system equally.*

In the *second* place, even if it were proved that the most copious determination of blood to the secreting parts took place, it would still remain to be shewn how determination to one organ could deplete another, with which it had no vascular connection directly, but only through the medium

* Except in the case of purging in inflammation of the liver, for reasons which the anatomy of that organ will render obvious ; but most probably very little is to be attributed to this cause. This instance, by the way, is particularly unfortunate for the determination of blood theory, as most purgatives increase the secretion of bile, while they must, if any thing, rather *diminish* the quantity of blood sent to the liver. In short, in so far as their action in this case helps to support the derivative theory, it tends to overthrow that of determination.

of the general system, in which case again it would operate like general bloodletting, and affect all organs equally. But as no one has even attempted to shew this, we must admit, that, in as far as the benefit derived from the so-called revulsives is to be attributed to the evacuation they produce, the quantity evacuated is the only circumstance to be taken into account, and that it is of no consequence from what organ that quantity is obtained. But that the benefit derived from revulsives follows any such rule, is notoriously not the case, as, for example, purgatives are particularly useful in affection of the brain, and diaphoretics of the chest, &c. ; not to speak of epispastics, of which the utility bears no proportion at all to the quantity evacuated.*

Besides all this, the hypothesis of “determination of blood,” like the iatro-chemical theories of modern days, is only brought forward when required, for the explanation of some particular case, but is totally forgotten, or carefully kept in the background, in other cases when its action would be useless or injurious. For example, cathartics

* This argument and the following are applicable to all the theories of determination of blood, however that determination be supposed to be effected ; whether by the increased action of arteries of Stahl, or the active dilatation of Parry, or the increased attraction of capillaries of Pring.

are said to be useful in diseases of the head, by causing a determination to the intestinal canal ; but, in general, no mention is made of this determination when they are employed in dysentery and enteritis. Cathartics are also said to be useful in amenorrhœa, by determining blood to the uterus ; but they are equally useful in menorrhagia and inflammation of that organ.*

Leeches, sinapisms, blisters, &c., to the hypogastrium, mammæ, &c., are also said to determine the blood to the uterus in amenorrhœa : but again, when they are found useful in menorrhagia, their former effect is quite lost sight of.† Emetics are said to be useful in internal inflammations, by producing determination to the surface ; but as their effect in this way would be a bad reason for

* In the latter cases, however, it is supposed by Dr Burns, that they divert the current from the uterus ; an opinion which it is difficult to reconcile with the former one

† One would have thought that the case of the Hungarian Sisters was sufficient almost of itself to set at rest for ever the question of determination of blood as a cause of increased secretion. In that remarkable case two females were joined together at the sacrum, but each had all the organs perfect except the rectum and vagina, which were common ; also the aortæ and venæ cavæ, communicated before the iliac vessels were given off, yet the two individuals menstruated at different periods and in different quantity ; which could not have happened if that secretion had depended on the “ determination of blood to the descending aorta ” according to the opinion of Cullen. (*Phil. Trans.* vol. 1. p. 311.)

employing them in erysipelas, it is conveniently forgotten.

Further, in some revulsives, the evacuation is so trifling in quantity as to be totally inadequate to explain the benefit derived from them,—as in blisters and emetics. Others produce positively no evacuation at all, viz. rubefacients, which are nevertheless exceedingly useful and powerful agents. Others again, not only do no good in the way of derivation or evacuation, but are positively hurtful, during their operation, in their effects on the circulation, viz., emetics, of which the effect in obstructing the circulation must be particularly injurious in inflammatory affections of the head, and more or less so in those of all other organs, yet they are very useful in cynanche, ophthalmia, hæmoptysis, &c.

From these arguments we may conclude, that the revulsives, considered as a class, have a beneficial action independent of any evacuation; and 2d, that in none of them, not even in those which produce the most copious evacuation, is any of the benefit to be attributed to derivation of blood. We may now proceed to consider the hypothesis of

Counter-Irritation.—It was long ago observed, even during the triumph of the Humoral Patho-

logy, that many inflammatory diseases were as effectually relieved by metastasis, or by the application of epispastics, which produced no evacuation, as by critical discharges or evacuant remedies : a circumstance which could not be explained on the principle of evacuating peccant matter, and, therefore, pathologists were placed in a serious dilemma. “ In order,” says Dr Fletcher,* “ to meet this emergency, it became necessary to frame a special law. It was accordingly enacted by the Father of Medicine, that the constitution could not suffer from two preternatural irritations at the same time, and that thus when a secondary irritation had been set up, the primary one was necessarily alleviated or removed.” That such a principle exists as an ultimate law of the animal economy, is an assumption purely gratuitous, if not absolutely false, and therefore it cannot be admitted as an explanation of the action of these remedies, but must be regarded as a simple expression of the fact, that the cure of an inflammatory disease is often observed to be connected with the appearance of another inflammation at a distant part. And if we examine a little farther into the matter, we shall find that the foregoing account of the

* See Probationary Essay to the College of Surgeons “ On the Action of Remedies reputedly revulsive.”

nature of inflammation, and analogy with the direct remedies already mentioned, do not warrant us in the conclusion that revulsives act by any withdrawal of irritation. For when we see that direct applications to inflamed parts are decidedly stimulant and increase irritation, what right have we to presume that indirect remedies, such as revulsives, act by withdrawing irritation?—obviously none. Is it not contrary to the plainest rules of common sense to add more irritation to a part already suffering too much, as in inflammation it is so represented; yet do we not every day see turpentine, alcohol, collyria, gargles, astringent washes, and other highly irritating substances, applied to burns and other external inflammations? These substances cannot surely be said to withdraw irritation; and if so, on what principle, in other inflammations, can a blister applied as near as possible, or a stimulating medicine to one closely connected by sympathy, to the inflamed part be said to do so? Also, if blisters and counter-irritants acted by withdrawing irritation, one would naturally think that the farther they were placed from the diseased part the better would be their effect (as was formerly inculcated); but experience has shewn that the contrary is the case, and that they must be placed as near as pos-

sible to the inflamed part. And, again, if counter-irritants in reality belonged to the class of remedies which diminish action, such as depletives (with which they are often, but incorrectly, classed), they ought to be proper at the very commencement of inflammatory diseases; but we know that in many they are useless, or even injurious, till the excitement of the heart has been partly subdued.

Let us now examine whether counter-irritants really do, under other circumstances, cause diminution of action at distant parts, as they are supposed to do in inflammation. Blisters and other counter-irritants are never said, by their local stimulant effect, to diminish the action of the general system, but are, on the contrary, avowedly general stimulants, and as such recommended and found useful in typhoid fever. They are as certainly stimulants to the parts in the neighbourhood of which they are applied; else for what reason would they be used in paralytic affections, along with electricity, galvanism, strychnia, &c.? This is indeed generally acknowledged by authors on the *Materia Medica*, for we find in Duncan's *Dispensatory* (art. *Cantharides*), that one of the indications for the use of blisters is "to increase the activity of a particular organ." Such being the

case, with what degree of consistency can medical men use counter-irritants, for example, in amaurosis, with the view of adding a stimulus, and at the same time use the same means in ophthalmia with the view of withdrawing irritation? or, in short, use counter-irritants in any inflammatory diseases, consistently with the purpose for which he employs them in paralytic affections, if he at the same time believes inflammation to be an increased action?*

Do medical men really believe that counter-irritants possess the power of in one case communicating irritation, and in another withdrawing it? and if so, are they agreed as to how these remedies are, to know for what purpose they are applied? for in other respects their mode of application is precisely the same in both cases.

After these considerations, and what has been said before of the nature of inflammation, I think that little hesitation can be felt in adopting the opinion of Dr Fletcher, that these remedies act by communicating through sympathy a stimulus to the inflamed part; and thus they act indirectly in precisely the same manner as local applications do directly.

* For what purpose does Dr Stokes apply a blister over the heart in the last stage of typhus along with the internal administration of the most powerful stimulants? is it to withdraw irritation? Certainly not; but it is also useful in pericarditis.

Accordingly we find, that the benefit derived from revulsives is in proportion as the sympathy between the diseased organ and that acted on is intimate or the reverse, and not at all in proportion to the quantity evacuated. Thus the utility of purgatives can be ascribed in a small degree only to the evacuation they produce, but may be preferred to the extensive sympathy that exists between the intestinal canal and other organs, so that a stimulus acting on it may indirectly affect almost all parts of the body, and more particularly those with which the sympathy is the closest—as the brain: hence purgatives are especially useful in affections of that organ, while in affections of the chest they are not so beneficial, although the evacuation may be equally copious in both cases. The utility of emetics—which evacuate nothing—may be accounted for on the same principle. In diaphoretics also, very little is to be attributed to the evacuation which takes place slowly, and is probably soon compensated for by the greater quantity of fluid drunk. Epispastics in general, it is scarcely necessary to say, act almost entirely, and rubefacients entirely, by the sympathetic stimulus which they afford. In fact, any evacuation may be regarded rather as incidental than necessary to the operation of revulsives, and we may

conclude that their real action in inflammatory diseases, is that of furnishing a sympathetic stimulus to the debilitated capillaries.

III. *Remedies which stimulate the Capillaries through the general System.*—We come now to the consideration of those remedies which cure inflammation by acting through the system on the part affected. “If we had medicines,” says Mr Hunter, p. 440, “which, when given internally could be taken into the constitution, and were endowed with a power of making the vessels contract, such, I apprehend, would be proper medicines.” (In inflammation.)

Now, all stimuli have the power of making the vessels contract; but as every organ possesses its peculiar irritability, and as every stimulus possesses some power more or less specific or peculiar to itself, one stimulus may be useful in one inflammation and another in another. We may therefore consider these remedies under the heads of those which have a tonic or stimulant power over the capillary system in general, and those whose powers are adapted to the specific irritability of individual organs.

Action of General Tonics.—Among these may

first be mentioned mercury. Mercury, we know, possesses a more powerful stimulating influence on the capillaries than almost any other medicine, and accordingly it has been employed with great success in inflammation of almost every organ of the body. The explanation of the action of calomel and opium is in these cases simple and satisfactory on the theory of diminished action: in fact, mercury gives us precisely what is required in the treatment of inflammation, viz. a remedy which will stimulate the capillaries without at the same time increasing the action of the heart.

Mercury in its physiological action is described by all authors on the *Materia Medica* as a powerful and universal stimulant to the capillary system. Such being the case, one would naturally think, that in a disease consisting essentially in increased action of these vessels, as inflammation is usually considered to be, it would be the very last substance recommended as a remedy, but, on the contrary, would be exhibited with extreme caution where other indications were to be fulfilled, from its tendency to stimulate those vessels already in a state of increased action. But experience has shewn, that so far from being hurtful, it is of all single remedies the most powerful and useful in the cure of inflammation. Here there is

a strange discrepancy between theory and experience; how, then, are they to be reconciled? Surely, as we can hardly expect a mineral to change its properties, some modification will be introduced into a theory which is so contrary to experience. No such thing, however, happens; theories are not so easily changed, but mercury suddenly becomes “an antiphlogistic,” or “a sedative,” or “appears to have a peculiar power in arresting or controlling the action of the capillaries,” or “a specific,” or, in short, any thing but what it was before, viz. a stimulus to the capillaries.

In the same way may be explained the action of other tonics, as bark, arsenic, iron, and tartar emetic, which are often useful in inflammatory affections, especially the last, which fulfils both, the indications, viz. depresses the heart's action, while it stimulates the capillaries. The action of tartar emetic in inflammatory diseases, pneumonia in particular, affords another good example of that inconsistency of theory with practice, which has long been the reproach of medicine; and also the extreme looseness of reasoning displayed in the attempts usually made to reconcile them. Tartar emetic, which stimulates the capillaries of the skin so powerfully as to produce suppuration, and those of the intestinal mucous membrane, so as to

be ranked among irritant poisons, becomes suddenly, when required, by Razori and others, who hold the doctrine of increased action, a sedative, and neutralizes the excess of stimulus in the system. It is true that this remedy possesses the power of depressing the heart's action in a greater degree than simple nauseants, which effect I do not mean to consider here, although it may be said that the idea of any sedative influence transmitted to the heart is very improbable, if not quite inconceivable; but that any such sedative influence is extended to the diseased part, is a hypothesis purely gratuitous, and particularly unfortunate with respect to the lungs, as it is a fact well established, that in poisonous doses that remedy occasions inflammation of these organs. So that whatever be the other effects of tartar emetic, it is incumbent on those who hold the doctrine of increased action, to shew why that substance is not positively and fatally injurious in inflammation of the lungs.

Action of Specifics.—We may now consider those remedies which are useful, by affording a stimulus adapted to the specific irritability of individual organs. It is manifest that, as all remedies for Inflammation (except depletives) are stimuli, they

are identical with exciting causes ; and as in Inflammation they act by affording a stimulus just sufficient to raise the irritation *up to* the natural standard, so in the healthy body they must be apt to irritate these same vessels *beyond* the line of health, and, if sufficiently powerful, to produce such a collapse as to constitute an Inflammation. Therefore the power of any medicine to *produce Inflammation of any organ*, must be a test of its power as a stimulus adapted to the specific irritability of that organ ; and consequently of its *utility in curing Inflammation of that organ*, arising from another cause, *i. e.* the collapse from another stimulus.

We may thus explain the operation of many of those remedies, whose action is generally considered anomalous, and contrary to the received laws of therapeutics. For example, tartar emetic in cases of poisoning is found to produce inflammation of the lungs ; this effect proves it to be a stimulus peculiarly or specifically adapted to the irritability of the capillaries of these organs, and therefore it is useful in diminished action of these capillaries *i. e.* Pneumonia.

Cantharides, the turpentine, and balsams have the power of irritating, the mucous membrane of

the urinary organs; they are therefore useful in gleet, catarrh of the bladder, &c.

Copaiba produces heat and irritation of the urethra, and therefore it is a stimulus well adapted to the vessels of that part when in a state of collapse from the action of the gonorrhœal virus, *i. e.* gonorrhœa.

In the same way may be explained the action of purgatives in diarrhœa and dysentery, of acetate of lead in ptyalism,* &c., also the action of mercury which occasionally produces iritis, laryngitis, and a great variety of inflammatory affections, and its efficacy in curing these and others is universally acknowledged.

It is unnecessary to repeat in detail the explanation of the action of these remedies; but we may take, as *instar omnium*, the explanation as given by Dr Fletcher, of mercury in iritis. "In the healthy state of the capillary vessels of the iris, their calibre is natural; because the stimuli are natural and the irritability is natural; but the introduction of a new stimulus, viz. mercury, specifically adapted to the irritability of those vessels (in common with those of many other organs) excites an inordinate irritation or contraction, followed

* It must be remembered, that every increased secretion differs from inflammation only in degree. (See p. 32.)

sooner or later by a proportionate collapse, in which inflammation consists. Now, what substances should we, *a priori*, conclude would be best adapted to bring up the vessels again to their ordinary state of contraction? Any revulsive remedy (as we cannot act on the part directly) may be presumed capable of doing this to a greater or less degree, but unquestionably, that will be the most efficacious which, having already evinced its specific power of exciting such an irritation on the vessels of the iris as to produce inflammation while healthy, will produce just such an irritation, as will raise the irritation to the healthy standard in those vessels which are now acting below par, and thus cure it."

CONCLUSION.

In conclusion it may be remarked, that the foregoing views are not matters of merely speculative interest, but are of great practical value: for while on the one hand, they point out to us the benefit which may be derived, in inflammatory diseases, from the more extensive use of moderate doses of remedies which have atonic influence on the capillaries; they, on the other hand, teach us the danger which must attend the abuse of our

ordinary remedies. For, as has been shewn, these remedies are themselves stimuli, and must therefore, if given in excess, infallibly aggravate inflammation,—a circumstance seldom adverted to by the generality of practitioners, and consequently their treatment often proves ineffectual,—not from the deficiency, but the excess of the remedies employed.

FINIS.

